ELECTRICAL 1

COURSE DESCRIPTION

This course, which is the first level of electrical, will provide basic skills and knowledge related to residential and commercial electrical systems. Course content includes leadership development, safe practices, Ohm's law, installing conduit, conductors, residential and commercial electrical systems and services according to National Electrical code (NEC) and local codes. This course gives students an introduction to the skill and knowledge base typically required for apprentice electricians.

Prerequisite(s): Construction Core

Algebra I or Math for Technology II (may be concurrent)

Recommended Credits: 2

Recommended Grade Level(s): 11th

ELECTRICAL I STANDARDS

1.0 Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

2.0 Students will assume responsibility for the safety of themselves, their coworkers, and bystanders.

3.0 Students will interpret, lay out, and fabricate in conformance to construction drawings and written specifications.

4.0 Students will use safe practices when working with electrical systems.

5.0 Students will analyze, construct, and evaluate DC circuits.

6.0 Students will research and use as a resource the National Electrical Code (NEC).

7.0 Students will analyze the requirements of and install residential electrical systems.

8.0 Students will analyze, design, and assemble both single and polyphase AC circuits.

9.0 Students will analyze electrical grounding practice and demonstrate correct grounding in accordance with the National Electrical Code.

10.0 Students will demonstrate splicing, terminating, and insulating of conductors.

11.0 Students will install common types of conduit.

12.0 Students will install conductors in accordance with NEC and local codes.

13.0 Students will identify switches, receptacles, and label disconnect devices as specified by National Electrical Code (NEC) and Occupational Safety and Health Administration (OSHA) regulations.

14.0 Students will pull conductors through conduit and cable trays.

15.0 Students will install commercial electric services.

ELECTRICAL 1

STANDARD 1.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The student will:
1.1 Exhibit positive leadership skills.
1.2 Participate in SkillsUSA-VICA as an integral part of classroom instruction.
1.3 Assess situations and apply problem-solving and decision-making skills to particular client relations in the community, and workplace.
1.4 Demonstrate the ability to work cooperatively with others in a professional setting.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
1.1.A Demonstrates character, leadership, and integrity using creative and critical-thinking skills.
1.2.A Applies the points of the creed to personal and professional situations.
1.2.B Participates and conducts meetings and other business according to accepted rules of parliamentary procedure.
1.3.A Analyzes situations in the workplace and uses problem-solving techniques to solve the problem.
1.4.A Participates in a community service project.
1.4.B Assists with an officer campaign with Tennessee SkillsUSA-VICA.

SAMPLE PERFORMANCE TASKS

- Create a leadership inventory and use it to conduct a personal assessment.
- Participate in various SkillsUSA-VICA programs and/or competitive events.
- Evaluate an activity within the school, community, and/or workplace and project effects of the project.
- Implement an annual program of work.
- Prepare a meeting agenda for a SkillsUSA-VICA monthly meeting.
- Attend a professional organization meeting.
- Participate in the American Spirit Award competition with SkillsUSA-VICA.

INTEGRATION LINKAGES

SkillsUSA-VICA, *Professional Development Program,* SkillsUSA-VICA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Math, Math for Technology, Applied Communication, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

ELECTRICAL I

STANDARD 2.0

Students will assume responsibility for the safety of themselves, their coworkers, and bystanders.

LEARNING EXPECTATIONS

The student will:

2.1 Implement safety procedures established by the Environmental Protection Agency (EPA), Occupational Safety & Health Administration (OSHA), and Hazard Communication (HazCom) regulations.

2.2 Comply with Occupational Safety & Health Administration (OSHA) rules and regulations.

2.3 Analyze and categorize safety and health hazards and their prevention and treatment in the construction industry.

2.4 Exhibit acceptable dress and personal grooming identified by the construction industry.

2.5 Demonstrate first aid practices.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

2.1 Establishes and maintains a safe and healthy working environment.

2.2.A Maintains electrical equipment and laboratory in a safe and clean condition.

2.2.B Passes with 100% accuracy a written examination relating specifically to electrical safety issues.

2.2.C Passes with 100% accuracy a performance examination relating specifically to electrical systems.

2.2.D Maintains a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.

2.3 Distinguishes and employs preventive measures of ecological, chemical, and physical contaminants.

2.4 Compares and contrasts acceptable dress and personal grooming for specific jobs in the construction industry.

2.5 Administers simulated basic first aid procedures, including treating burns, cuts, electrical shock, and administering the Heimlich Maneuver.

SAMPLE PERFORMANCE TASKS

- Conduct a safety and health inspection and identify any potential hazards.
- List causes of most common accidents and outline a safety prevention program.
- Participate in the Occupational Health and Safety competitions with SkillsUSA-VICA.
- Outline a safety management program.
- Develop emergency policies for the construction laboratory.
- Role-play proper procedures for treating burns, cuts, electrical shock, and administering the Heimlich Maneuver according to standards set forth by the American Red Cross.
- Participate in a practice drill simulating a hazardous solvent spill in which an emergency action plan is to be implemented.

- Prior to assigning a task using power tools, the instructor removes some required safety items and instructs students to perform an inspection of tools.
- Instruct a visitor to obviously approach the vicinity of a student conducting a hazardous activity and note the level of awareness demonstrated by the student.
- For a project requiring the use of ladders and/or scaffolding, note the proper placement and securing procedures followed by students.
- In a project requiring solvents or adhesives, introduce a new brand or type and require students to retrieve the material safety data sheet (MSDS) and identify possible health hazards.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

ELECTRICAL 1

STANDARD 3.0

Students will interpret, lay out, and fabricate in conformance to construction drawings and written specifications.

LEARNING EXPECTATIONS

The student will:

3.1 Interpret dimensions and locations of components that are explicitly dimensioned in construction drawings and written specifications.
3.2 Scale dimensions that are not explicitly included in construction drawings.
3.3 Interpret plan and elevation views shown in construction drawings.
3.4 Recognize and correctly interpret lines and symbols commonly used in construction drawings.
3.5 Make layouts of locations and elevations of structural elements, such as forms and electrical and plumbing stub-ups, based on job site control points on construction drawings.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

3.1.A Makes a material take-off in conformance to construction drawings and specifications.
3.1.B Lays out components, structural and others, and their locations to dimensions and tolerances indicated on construction drawings and written specifications.
3.2.A Uses the scale of a drawing to determine locations not explicitly dimensioned.
3.2.B Uses the scale of a drawing to determine dimensions not explicitly shown on drawing.
3.3.A Interprets three-dimensional features found in construction drawings.
3.4.A Distinguishes between object lines, dimension and extension lines, center lines, section lines, and other lines commonly found in construction drawings.
3.4.B Identifies symbols commonly used in construction drawings, including material, window and door, electrical, plumbing, HVAC, and plot plan and survey symbols.
3.5A Lays out corner locations and elevations for a building structure, based on construction drawings and measurements from control points.
3.5B Determines locations of plumbing and electrical stub-ups, based on construction drawings and measurements from structure layout.

SAMPLE PERFORMANCE TASKS

- Construct batter boards and lay out a foundation plan based on a construction drawing, including grade stakes, locations of concrete forms, and plumbing and electrical stub-ups, e.g., using stakes, hammers, steel tapes, and builder's levels.
- Given a set of plans and specifications for a residential or a commercial structure, make a complete take-off for one or more of the following: the framing material, door and windows, electrical equipment, or plumbing fixtures.
- Given a set of plans and specifications for a residential or a commercial structure, determine the location of elements not explicitly dimensioned.

- Determines the detail of a stair structure or roof structure shown in construction drawings.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

ELECTRICAL 1

STANDARD 4.0

Students will use safe practices when working with electrical systems.

LEARNING EXPECTATIONS

The student will:

4.1 Evaluate the potential risk of injury from electrical shock, burns, and arc blasts.
4.2 Research various types, applications, and care of protective equipment for electrical workers.
4.3 Practice industry and company safety policies and standards.
4.4 Evaluate the potential risk of injury from non-electrical risks.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

4.1.A Demonstrates methods to prevent injury from electrical shock.
4.1.B Demonstrates methods to prevent injury from electrical burns.
4.1.C Demonstrates methods to prevent injury from arc blasts.
4.2.A Selects, inspects, and uses personal protective equipment, such as rubber gloves, and head, eye, and face protection.
4.2.B Selects and uses special tools, such as hot sticks and shorting probes.
4.3.A Identifies possible risks and completes reports of safety violations.
4.3.B Complies with applicable safety policies and standards.
4.3.C Demonstrates de-energizing the circuit.
4.3.D Completes lockout/tagout procedures.
4.3.E Reports safety hazards to supervisors and safety personnel.
4.3.F Passes with 100% accuracy a written examination relating specifically to electrical safety issues.
4.3.G Passes with 100% accuracy a performance examination relating specifically to electrical systems.
4.3.H Maintains a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.
4.4.A Explains the potential risk of injury from falls and falling objects, and the recommended risk mitigation procedures.
4.4.B Explains the potential risk of injury from confined space entry, and the recommended risk mitigation procedures.
4.4.C Explains the potential risk of injury from respiratory hazards, and the recommended risk mitigation procedures.

SAMPLE PERFORMANCE TASKS

- Students will assess risk factors, address safety policies and standards, etc., to the instructor's satisfaction, for tasks such as those described below, and then execute the task (real or simulated).

- Replace a 20A circuit breaker in a 277V lighting subpanel, where activity in the building precludes de-energizing the entire subpanel.
- Tighten a loose through-bolt on a one-barrel fixed-tongue compression connector used to connect a 500-KCMIL wire to a 12V, 2000A electroplating power supply.
- Change a ballast on a 277V, four-tube, ceiling-mounted, fluorescent lighting fixture mounted 18 feet above the floor.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER 26101

ELECTRICAL 1

STANDARD 5.0

Students will analyze, construct, and evaluate DC circuits.

LEARNING EXPECTATIONS

The student will:

5.1 Research the relationship among the variables expressed in Ohm's Law.
5.2 Calculate unknown values of current, voltage, or resistance in resistive DC circuits using Ohm's Law.
5.3 Calculate unknown values of current, voltage, resistance, or power in resistive DC circuits using the power formulas.
5.4 Calculate the resistance of conductor, given the resistivity of the metal from which it's made, it's cross-sectional area, and it's length.
5.5 Conduct electrical tests using appropriate test equipment.
5.6 Analyze DC resistive circuits.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

5.1.A Evaluates current and how it is measured.
5.1.B Analyzes voltage and how it is measured.
5.1.C Analyzes resistance and how it is measured.
5.1.D Explains the relationship between current, voltage, and resistance in a resistive DC circuit.
5.2.A Predicts unknown values of current, voltage, or resistance in resistive DC circuits using Ohm's Law and confirms their values by measurement.
5.3.A Calculates voltage and current.
5.3.B Calculates resistance and power
5.4.A Calculates the resistance of a length of conductor, given the metal from which it's made, it's cross-sectional area, and it's length.
5.5.A Measures voltages in DC resistive circuits using meters: those applied to circuits and voltage drops across individual components.
5.5.B Measures currents in DC resistive circuits using meters: the total current through a circuit and the current through an individual component.
5.5.C Measures resistances in DC resistive circuits using meters: the total resistance of a circuit and the resistance of an individual component.
5.5.D Measures high resistances, such as insulation between conductors in a cable, using a megohm meter.
5.5.E Reports test requirement results written and verbal.
5.6.A Calculates equivalent resistances in series circuits, and verifies by measurement.
5.6.B Calculates equivalent resistances in parallel circuits, and verifies by measurement.
5.6.C Calculates equivalent resistances in series-parallel circuits, and verifies by measurement.

SAMPLE PERFORMANCE TASKS

- Design the cabling specifications to supply DC voltage to a 7 kW, 250VDC motor atop a 65-meter radar antenna tower such that the DC voltage drop is insignificant.
- Given the required length, allowed voltage drop, and maximum current for a tubular aluminum conductor, calculate the minimum cross-sectional of the conductor.
- Design, construct a mock-up, and measure voltage and currents for a 12V auxiliary power system in a travel trailer, consisting of lights of different power ratings, DC motors, and a power invertor, including consideration of conductor lengths and allowable voltage drops.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER 26104, 26105

ELECTRICAL 1

STANDARD 6.0

Students will research and use as a resource the National Electrical Code (NEC).

LEARNING EXPECTATIONS

The student will:

6.1 Select specific information relevant to an assigned task related to conductors in the National Electrical Code (NEC).

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

6.1.A Determines allowable current in a specified conductor.

6.1.B Determines the maximum number and sizes of conductors in a conduit of given dimensions.

6.1.C Determines the spacing of clamps and supporting devices for conduit and cables.

6.1.D Determines the spacing of clamps and supporting devices for conduit and cables.

SAMPLE PERFORMANCE TASKS

- Given the size and number of conductors required in an underground conduit to a separate paint-shop building, determine the minimum conduit diameter.
- Install a specified run of electrical metal tubing (EMT) conduit on a masonry wall using the proper spacing of clamps and supports.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER 26107

ELECTRICAL 1

STANDARD 7.0

Students will analyze the requirements of and install residential electrical systems.

LEARNING EXPECTATIONS

The student will:

7.1 Calculate electrical loads based on information in residential blueprints.
7.2 Design residential service equipment based on residential blueprints and applicable requirements.
7.3 Install all components typical of residential electrical systems.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

7.1.A Analyzes blueprints to identify planned electrical systems in a residence.
7.1.B Researches National Electric Code for Compliance or electrical systems.
7.1.C Determines general lighting loads in a residential electrical system, including demand factors.
7.1.D Determines large appliance loads in a residential electrical system, including applicable demand factors.
7.1.E Determines total VA capacity required in feeder conductors in a residential electrical system.
7.2.A Determines the size of feeder conductors and required physical structures for a residential electrical system.
7.2.B Determines the size and enclosure specifications of the load center.
7.3.A Installs required mounting and junction boxes typical of residential construction.
7.3.B Installs cable and conduit typical of residential construction, and pulls conductors through conduit as required.
7.3.C Makes final electrical connections to large appliances typical of residential construction.
7.3.D Completes the installation of wiring of the electrical service.
7.3.E Evaluates wiring showing National Electrical Code compliance.

SAMPLE PERFORMANCE TASKS

- Prepare a written procedure for the actual construction plan to complete the electrical wiring for a residential electrical system based on a blueprint.
- Produce a 32 ft^2 mockup of a residential service, including two to four typical residential electrical systems, such as a kitchen electrical system, HVAC electrical system, lighting and convenience plugs system, and so forth. Project steps should include blueprint of the mockup, bill of materials, simulated electrical inspections, completion of wiring, and functional testing.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER 26110, 26112

ELECTRICAL 1

STANDARD 8.0

Students will analyze, design, and assemble both single and polyphase AC circuits.

LEARNING EXPECTATIONS

The student will:

8.1 Research the effects of parameters unique to AC circuits, such as inductance, capacitance, reactance, impedance, AC power, and power factor.
8.2 Determine the power factor of a circuit.
8.3 Evaluate the construction and operations of transformers, both single phase and polyphase.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

8.1.A Calculates inductance of simple air-core coil configurations.
8.1.B Calculates the reactance produced by an inductor or a capacitor.
8.1.C Calculates the impedance produced by an inductor or a capacitor.
8.1.D Calculates the impedance of a circuit containing inductive reactance, capacitive reactance, and resistance.
8.2.A Predicts phase angle between the current and voltage waveforms, given resistance, inductance, and capacitance of the circuit.
8.2.B Calculates and measures the power factor of a circuit, given resistance, inductance, and capacitance of the circuit.
8.3.A Calculates and measures the no-load input-output voltage ratios of a transformer, given the turns ratio of the transformer windings.
8.3.B Predicts and measures the current relationship between primary and secondary of a transformer.
8.3.C Constructs the basic star and delta connections of three-phase transformer circuits.
8.3.D Calculates and measures the voltages and currents in three-phase circuits.

SAMPLE PERFORMANCE TASKS

- Calculate the reactance of the primary winding by measuring the resistance of a transformer's primary winding and the no-load primary voltage and current.
- Use individual single-phase transformers to construct a star-to-delta transformation, calculating and measuring the input and output voltages.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER 26201, 26307

ELECTRICAL 1

STANDARD 9.0

Students will analyze electrical grounding practice and demonstrate correct grounding in accordance with the National Electrical Code (NEC).

LEARNING EXPECTATIONS

The student will:

9.1 Evaluate the need for electrical grounding, as related to prevention of electrical shock.
9.2 Utilize effective grounding practices, as prescribed by the National Electrical Code (NEC) and local code.
9.3 Analyze ground elements for services, such as water pipes and grounding electrodes.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

9.1.A Inspects extension cords for proper ground continuity before use with power tools that are not double-insulated, taking any needed remedial action.
9.1.B Predicts results when electrical grounding is insufficient.
9.1.C Explains and demonstrates step to treat electrical shock.
9.2.A Distinguishes between ground wires and neutral wires.
9.2.B Demonstrates connection of ground wires and installation of bonding straps.
9.3 Chooses ground wire sizes for making connections as required by the National Electrical Code (NEC) and local codes for *water pipes
*grounding electrodes
*building frames
*concrete-encased rebar.

SAMPLE PERFORMANCE TASKS

- Determine required ground wire for residential service or mockup.
- Identify and choose from allowable ground connections for a residential or commercial service.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER 26203

ELECTRICAL 1

STANDARD 10.0

Students will demonstrate splicing, terminating, and insulating of conductors.

LEARNING EXPECTATIONS

The student will:
10.1 Research National Electrical Code (NEC) and local code requirements for splicing, terminating, and insulating of conductors.
10.2 Demonstrate splicing, terminating, and insulating of conductors.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
10.1.A Evaluates common wire nuts for making connections and explains when and how to use.
10.1.B Explains which crimp-on wire lugs or mechanical compression connectors are acceptable in various situations.
10.1.C Analyzes special considerations for making splices and connections to aluminum conductors.
10.1.D Evaluates insulation systems applicable to common splices and terminations.
10.2.A Completes multiple wire connections using proper size wire nuts.
10.2.B Demonstrates wire terminations and splices using proper crimp-on wire lugs and mechanical compression connectors.

SAMPLE PERFORMANCE TASKS

- Complete wiring for residential service or mockup.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER 26208

ELECTRICAL 1

STANDARD 11.0

Students will install common types of conduit.

LEARNING EXPECTATIONS

The student will:

11.1 Select type and size of conduit for given electrical installations in accordance with National Electrical Code (NEC) and local codes.

11.2 Demonstrate electrical installations with electrical metal tubing (EMT) and polyvinyl chloride (PVC) conduit.

11.3 Demonstrate electrical installations with intermediate metal conduit (IMC) and rigid conduit.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

11.1.A Explains choices for type and size of conduit to comply with National Electrical Code (NEC) and local codes.

11.1.B Selects fittings and boxes which meet installation and code requirements.

11.2.A Demonstrates stub, offset, saddle, and parallel bends with electrical metal tubing (EMT) conduit.

11.2.B Demonstrates stub, offset, saddle, and parallel bends with polyvinyl chloride (PVC) conduit.

11.2.C Cuts and reams electrical metal tubing (EMT) and polyvinyl chloride (PVC) conduit.

11.2.D Installs and secures electrical metal tubing (EMT) and plastic conduit with clamps and fittings conforming to National Electrical Code (NEC) and local code.

11.3.A Demonstrates stub, offset, saddle, and parallel bends with intermediate metal conduit (IMC) and rigid conduit.

11.3.B Cuts, reams, and threads intermediate metal conduit (IMC) and rigid conduit.

11.3.C Installs and secures intermediate metal conduit (IMC) and rigid conduit with clamps and fittings conforming to National Electrical Code (NEC) and local code.

SAMPLE PERFORMANCE TASKS

- Given a proposed addition to a commercial electrical system, determine the type and size of conduit required to conform to National Electrical Code (NEC) and local code.
- Make stub bends to a specified height, offset bends to a specified depth and angle, and saddle bends to clear a specified obstacle. Repeats performance until industry standards are met.
- Given a starting and termination point, determine an optimum route to minimize the bends required for a conduit run.
- Given termination points and obstacles, determine an optimum route, make bends and cuts, install, and secure the conduit with proper clamps.
- Produce a 32 ft^2 or larger mockup of a three-phase commercial electrical installation, including a service and three subsystems. Project steps (also relevant to other standards)

should include blueprint of the mockup, bill of materials, simulated electrical inspections, completion of wiring, and functional testing.

- Participate in a class field trip to local commercial or industrial operating facility to view examples of large scale conduit, raceways, cable trays, and so forth.
- Repeat all performance tasks until industry standards are met including time standard.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER 26102, 26103, 26108, 26204

ELECTRICAL 1

STANDARD 12.0

Students will install conductors in accordance with National Electrical Code (NEC) and local codes.

LEARNING EXPECTATIONS

The student will:

12.1 Select and physically identify conductors and cables by accepted industry designation and suitably under National Electrical Code (NEC).
12.2 Pull conductors into conduits and raceways.
12.3 Connect conductors according to National Electrical Code (NEC).

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

12.1.A Categorizes conductors and cables based upon wires size and gauge, insulation and jacket types, and voltage ratings.
12.1.B Reads and identifies markings on conductors and cables.
12.1.C Uses tables in National Electrical Code (NEC) to determine current capacity of a conductor.
12.2 Demonstrates the ability to pull conductors into conduits and raceways.
12.3.A Adheres to National Electrical Code (NEC) requirements for color codes for grounded conductors and "high-leg" conductors.

SAMPLE PERFORMANCE TASKS

- For commercial and residential mockups, select and install proper conductors and cables in conduit. Repeat performance task until industry standards and time factor is achieved

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER 26109

ELECTRICAL 1

STANDARD 13.0

Students will identify switches, receptacles, and label disconnect devices as specified by National Electrical Code (NEC) and Occupational Safety and Health Administration (OSHA) regulations.

LEARNING EXPECTATIONS

The student will:

13.1 Categorize switches as to type, intended use, and the switch's compatible conductors.
13.2 Analyze requirements for proper labeling of disconnect devices as specified by National Electrical Code (NEC) and Occupational Safety and Health Administration (OSHA) regulations.
13.3 Evaluate switch enclosures as to type and intended use and National Electrical Manufacturers Association (NEMA) classification.
13.4 Evaluate receptacles based on voltage and current capacities.
13.5 Demonstrate proper wiring techniques when terminating conductors and devices.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

13.1.A Classifies single-pole switches as lighting and motor-control switches.
13.1.B Classifies double-pole switches and installs three-way lighting circuits.
13.2 Labels disconnect devices as specified by National Electrical Code (NEC) and Occupational Safety and Health Administration (OSHA) regulations.
13.3 Selects and installs switch enclosures based on type and intended use and National Electrical Manufacturers Association (NEMA) classifications.
13.4 Selects and installs receptacles based on voltage and current capacities.
13.5 Terminates receptacles, switches, and other devices.

SAMPLE PERFORMANCE TASKS

- Select and use proper switches in lighting and motor control circuits in residential and commercial mockups.
- Install permanent labels as required on disconnect devices in residential and commercial mockups.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, SCANS, Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), NCCER, International Brotherhood of Electrical Workers, OSHA, Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER 26111

ELECTRICAL 1

STANDARD 14.0

Students will pull conductors through conduit and cable trays.

LEARNING EXPECTATIONS

The student will:
14.1 Plan and set up a cable pull through conduit and cable trays.
14.2 Compare manual and power fish-tape or cable-puller systems.
14.3 Demonstrate cable pull through assorted conduit configurations.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:
14.1.A Selects proper locations to start and end a conductor pull.
14.1.B Uses mandrel, swabs, and brushes to prepare conduit for conductors.
14.1.C Sets up conductor reels to assure proper feed during the pull.
14.2.A Installs manual and power fish-tape or cable-puller systems.
14.2.B Attaches conductors to manual and power fish-tape or cable-puller systems.
14.3.A Completes a cable pull through assorted conduit and pull-box configurations.
14.3.B Calculates allowable pulling tension for a specified group of conductors.

SAMPLE PERFORMANCE TASKS

- Pull multiple conductors through conduit runs in residential and commercial mockups. Repeat performance until industry standard is met including time factor.
- For a given group of conductors, calculate the allowable pulling tension.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER, 26206

ELECTRICAL 1

STANDARD 15.0

Students will install commercial electric services or mockups.

LEARNING EXPECTATIONS

The student will:

15.1 Install a three-phase load center, disconnects, meter equipment, a services entrance, and ground systems.
15.2 Install and connect star- and delta-connected three-phase service equipment.
15.3 Install and connect current and potential transformers in a commercial mockup.
15.4 Correctly wire three-phase 277/480-volt services with combined lighting and motor loads.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

15.1.A Given blueprints of a typical three phase commercial service installation, installs load center, disconnects, meter equipment, a services entrance, and ground systems.
15.2.A Installs and connects star- and delta-connected three-phase service equipment.
15.3.A Installs and connects current and potential transformers in a commercial mockup.
15.4.A Wires three-phase 277/480-volt services with combined lighting and motor loads.

SAMPLE PERFORMANCE TASKS

- Produce a 32 ft^2 or larger mockup of a three-phase commercial electrical installation, including a service and three subsystems. Project steps (also relevant to other standards) should include blueprint of the mockup, bill of materials, simulated electrical inspections, completion of wiring, and functional testing.

INTEGRATION LINKAGES

Science, Math, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), International Brotherhood of Electrical Workers, Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development, NCCER 26209

ELECTRICAL 1

SAMPLING OF AVAILABLE RESOURCES

National Center for Construction Education and Research (NCCER), *Core Curriculum*. Prentice Hall, Upper Saddle River, NJ; ©2000. Also known as the "Wheels of Learning" materials.
National Center for Construction Education and Research (NCCER), *Electrical Level One*. Prentice Hall, Upper Saddle River, NJ; ©2000. Also known as the "Wheels of Learning" materials.
National Center for Construction Education and Research (NCCER), *Electrical Level Two*. Prentice Hall, Upper Saddle River, NJ; ©2000. Also known as the "Wheels of Learning" materials.
National Center for Construction Education and Research (NCCER), *Electrical Level Three*. Prentice Hall, Upper Saddle River, NJ; ©1999. Also known as the "Wheels of Learning" materials.
National Center for Construction Education and Research (NCCER), *Electrical Level Four*. Prentice Hall, Upper Saddle River, NJ; ©1999. Also known as the "Wheels of Learning" materials.
International Brotherhood of Electrical Workers
United States Department of Labor